



Distant pedicle flaps for soft tissue coverage of severely burned hands: an old idea revisited[☆]

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Abstract

Burns to the hand that are complicated by exposure of bone, joint or tendon cannot be closed with conventional skin grafts and require flap procedures to prevent further damage. Local or regional flaps may be unavailable if electrical or blast trauma produces a large zone of injury, or when forearm burn injury extends beyond fascia. Free tissue transfer may not be tolerated by critically ill burn patients. In these circumstances, distant pedicle flaps are one option for safe and effective soft tissue coverage. Over a 5-year period, we have performed six distal pedicle flaps for coverage of exposed hand structures when local or free flaps were contraindicated or unavailable. The patients required an average of 4.5 surgical procedures to complete hand reconstruction and soft tissue coverage. Soft tissue coverage was completely successful in five patients and partially successful in one patient. Single stage local or free flaps remain the treatment of choice when burned hands cannot be covered with skin grafts. When these flap options are not available, distant pedicle flaps provide a safe alternative. © 2001 Elsevier Science Ltd and ISBI. All rights reserved.

Keywords: Burns; Hands; Wound repair; Pedicle flaps

1. Introduction

Burn injury to the hands or upper extremities is common, presenting in 70% or more of patients with thermal trauma [1–3]. Hand function may be adversely affected by even small surface area burns, and the treatment of such injuries is properly relegated to a multidisciplinary team. A typical team goal is the completion of hand soft tissue coverage by postburn day 14 and return of normal hand function within one year of injury [4]. In most cases, soft tissue coverage is achieved by normal wound healing or by placement of split thickness autografts.

When hand burns are deep, debridement may result in exposure of viable tendon, bone or joint. In the absence of periosteum or paratenon, these structures cannot be successfully covered with skin grafts, and will require a

flap procedure. The procedures of choice are locally based fascial or fasciocutaneous flaps or microsurgical free-tissue transfer.

In rare circumstances, none of these options will work. Extensive hand and extremity injury or the need to excise beyond fascia may make local flaps unavailable. Extensive electrical or blast injury may create a wide zone of injury making local flaps unreliable. Free tissue transfer may be contraindicated by the inability of a sick patient to tolerate a multi-hour surgical procedure, or by the non-availability of microsurgical expertise or equipment. In these circumstances, pedicle flaps derived from uninjured distant tissue provide an alternative method of hand soft tissue coverage. In this article, we describe several distant pedicle flaps that are useful when more traditional methods of hand coverage are not available.

2. Materials and methods

Over a 5 year period, six patients, comprising 0.4% of 1339 acute burn admissions, underwent distant flap coverage of burns to the hands. The patients had an

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average age of 35.6 years, and an average burn size of 25.1% total body surface area (Table 1). A multidisciplinary team of surgeons, nurses and occupational therapists as earlier described [4] undertook standardized treatment of patients with hand burns. In brief, burns of the hands were debrided, elevated, cleansed twice daily with chlorhexidine gluconate, and placed in mafenide acetate and/or silver sulfadiazine topical agents. Daily ranging and splinting commenced on the day of burn center admission.

All six patients survived their burn injury. Five of six patients had successful soft tissue coverage of their hand burns using distant flap procedures. The sixth patient had groin flap coverage to the dorsal index and long fingers simultaneous with amputation of nonviable ring and little fingers. Flap coverage of the index finger was successful, however, the middle finger and associated flap proved nonviable and were later amputated.

Final hand function could not be assessed, as our acute care burn center does not provide long-term rehabilitation or outpatient care. Follow-up was further complicated by the fact that four of the six patients undergoing hand flap surgery returned to other states or other countries upon completion of their treatment. The ultimate functional outcome of severely burned hands has been reported to be largely dependant upon the degree of initial injury [5]. Van Zuijlen et al. reported that the need for finger amputation following burn injury had a significant predictive value for poorer long-term hand function [6]. As a rough index of function, it should be noted that five of the six patients described required in-patient rehabilitation following burn center discharge, and both military patients treated with hand flaps were later medically discharged from the service. The need for inpatient rehabilitation or medical discharge reflected the severity of both the hand burns and the associated injuries for this group.

3. Case presentations

3.1. Random abdominal wall flap

A 13-year-old male with a 35% total body surface area (TBSA) burn/30% TBSA full thickness injury was admitted on postburn day 12, following a house fire. Debridement of the left hand resulted in exposed but viable extensor tendons on the dorsal fingers and hand. The left hand was buried under the abdominal skin anterior to the investing fascia (Fig. 1a). The operative site required re-exploration when the patient became febrile without other obvious source of infection. No evidence of operative site infection was found. Following three delay procedures, the hand was successfully covered and remained functional (Fig. 1b).

3.2. Groin flap

A 28 year old male was admitted with a 31.5% TBSA/14% TBSA full thickness flame injury. The skin of the dorsal left hand and fingers was nonviable and required debridement to the level of viable extensor tendons (Fig. 2a). The distal hand and fingers were covered with a groin flap. Following division of the flap, the fingers had stable soft tissue coverage, but retained the thickness of the groin skin (Fig. 2b). Liposuction to defat the flaps was subsequently performed, resulting in thinner skin coverage and normal hand function (Fig. 2c and Fig. 2d).

3.3. Tensor fascia lata flap

A 78-year-old male was injured while attempting to clean the gutters of his house with a metal pole. He contacted an electrical line resulting in a combined thermal and electrical injury along with a fall. The total burn size was 44% TBSA/43% TBSA full thickness injury.

Table 1
Distant pedicle flaps utilized for hand coverage

Patient #	Age/Sex	Burn size (TBSA) ^a		Associated injury	Flap utilized	Success of soft tissue coverage (%)
		Total (%)	3° (%)			
1	13 year M	35.0	30.0	Fracture of right long finger	Random abdominal wall	100
2	28 year M	31.5	14.0	Dislocation right shoulder	Groin flap	100
3	21 year M	1.8	1.6	Electrical injury	Random chest wall	100
4	78 year M	44.0	43.0	Electrical injury, fall	Tensor fascia lata	100
5	40 year M	16.0	7.0	Smoke inhalation, multiple organ failure	Groin flap	50
6	34 year M	22.3%	8.3%	Blast injury, evisceration traumatic finger/thumb amputation	Groin flap	100%

^a TBSA, total body surface area.



Fig. 1. Random abdominal wall flap.

The dorsal right hand was extensively injured, resulting in loss of extensor tendons and soft tissue cover (Fig. 3a). Temporary dressings were placed while the other burn injuries were addressed. On postburn day 49,

a nonfunctional little finger was amputated. The extensor digitorum minimum tendon was transferred to the ring finger, and tendon grafting to reconstitute extensor tendons to the middle and ring fingers was performed.

Soft tissue coverage was provided by a tensor fascia lata (TFL) flap developed from the lateral right thigh (Fig. 3b). The TFL flap was divided and inset on postburn day 76 resulting in successful soft tissue coverage of the hand and tendon repairs (Fig. 3c).

4. Discussion

The surgical management of dermal burns of the

hands is controversial, with some studies suggesting that functional outcome is more associated with occupational therapy rather than to method of skin coverage [4,7]. Nevertheless, most would agree that early wound closure is preferable to late, and that skin grafting, where indicated, shortens length of stay, reduces pain, and facilitates hand therapy [4].

No controversy exists over the need to surgically intervene when burn injury results in exposure of bone, joint or tendon. The method of choice remains immedi-



Fig. 2. Groin flap. Groin flap revision with liposuction.

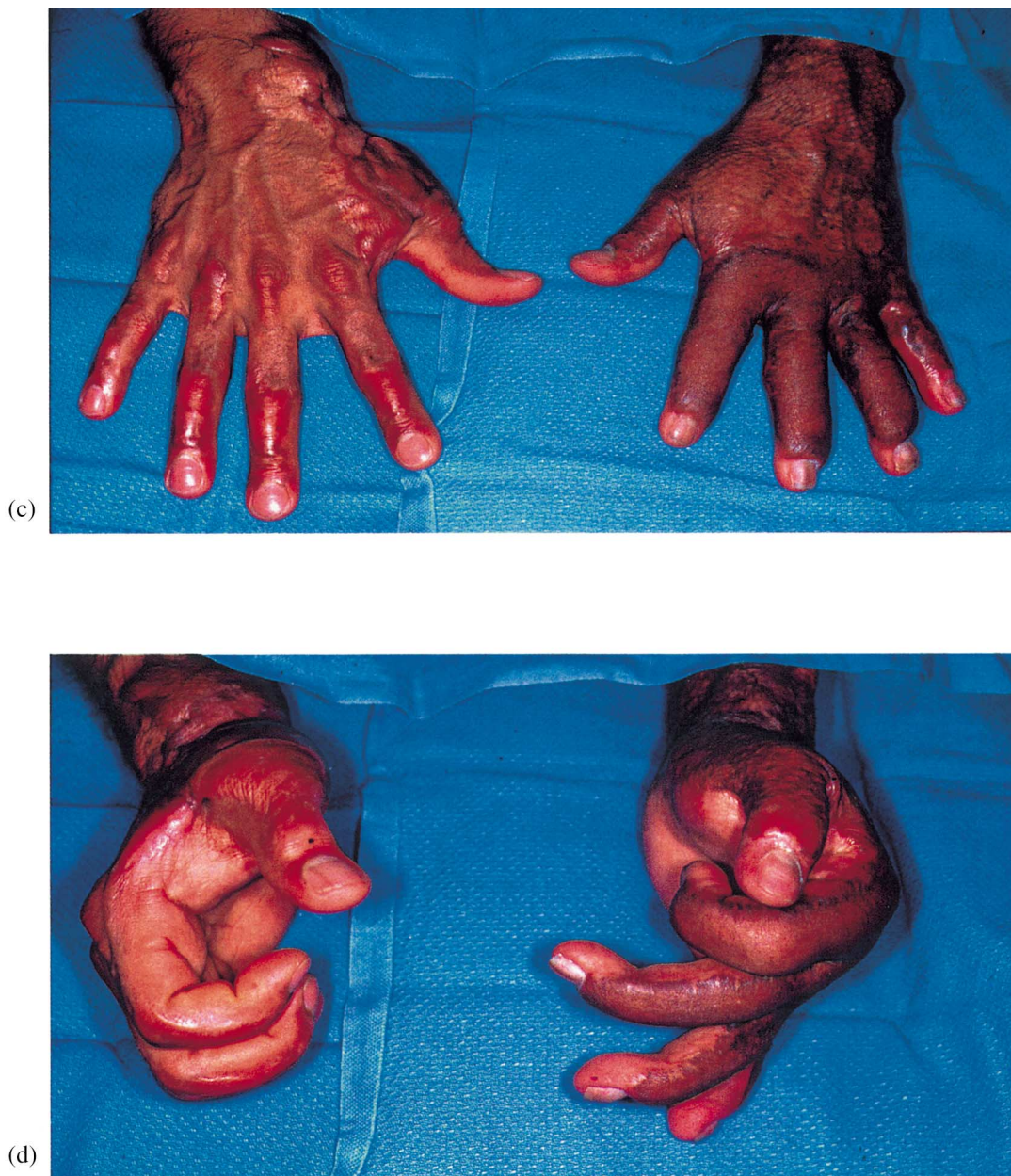


Fig. 2. (Continued)

ate coverage using local skin, fascial or fasciocutaneous flaps. When local flaps are unavailable, the second choice remains free tissue transfer. A small minority of patients will require yet a third choice, coverage using distant tissue transferred as a pedicle flap.

A number of distant pedicle flaps are available for hand coverage. The choice of flap depends upon the type of soft tissue coverage required, along with the experience of the surgeon involved. One simple solution is to utilize the Crane Principle [8]. Subcutaneous tissue can be carried on a skin flap placed temporarily over a wound defect. The skin flap, along with a thin

layer of subcutaneous tissue is later returned to the donor site, leaving a layer of subcutaneous tissue, suitable for skin grafting, over the original defect [9]. Other flap procedures leave skin and subcutaneous tissue attached at the recipient site. The random abdominal wall flap, groin flap and tensor fascia lata flap fit into this category and are described below. The cross-arm flap has also been utilized for acute coverage of burned hands [10].

The random abdominal wall flap has the advantage of simplicity, in that no knowledge of specific vascular anatomy is necessary to perform the procedure. The flap is suitable for coverage of the entire hand and

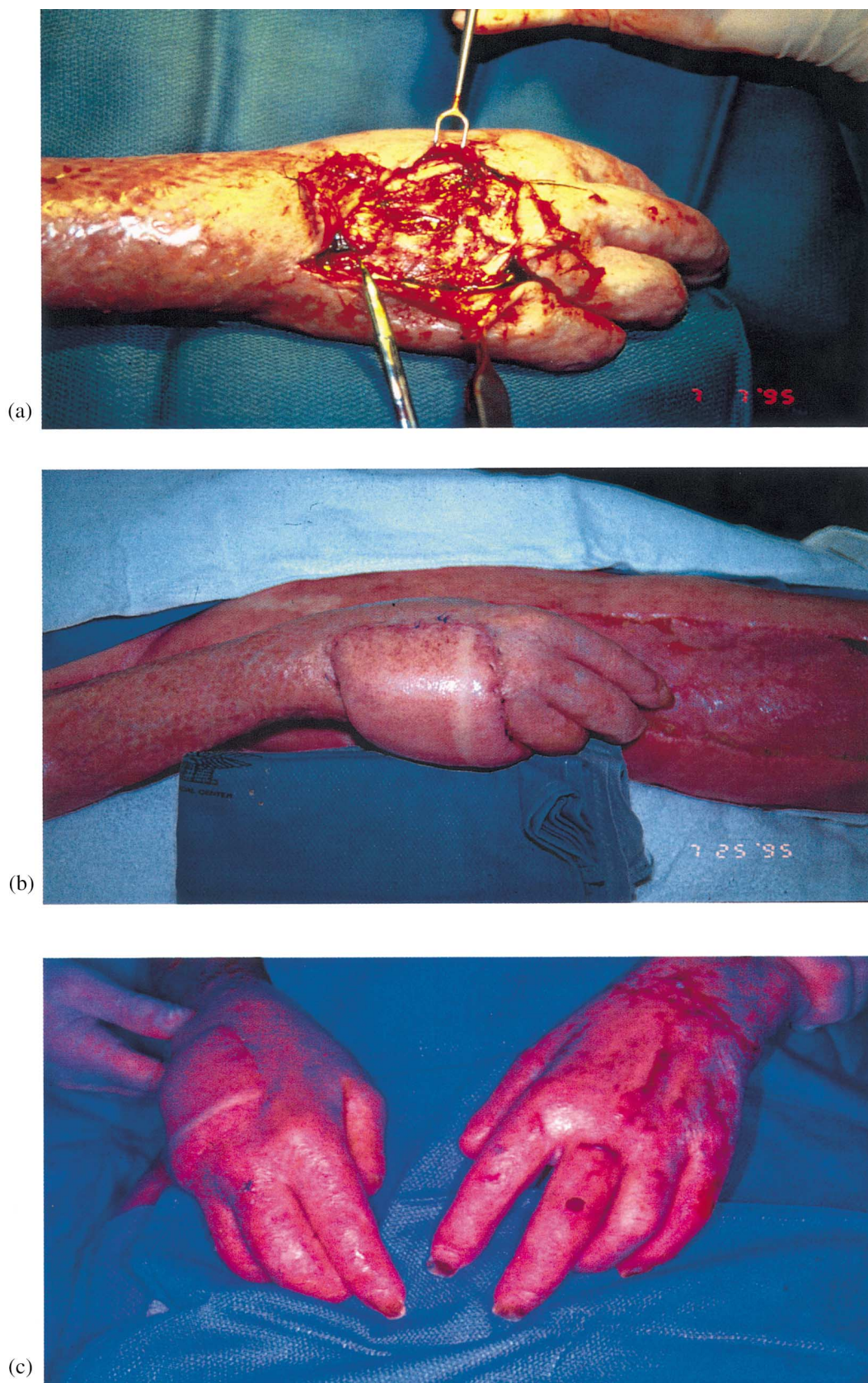


Fig. 3. Tensor fascia lata flap.

fingers. A disadvantage is that the covered hand is inaccessible for inspection in the event that the patient becomes febrile, occasionally necessitating operative exploration to rule out infection. A second disadvantage is that the transplanted skin retains the fat-cell characteristics of abdominal skin: increase in body weight will result in a thickening of the transposed abdominal skin as well as increased abdominal girth. Finally, the immobility of the hand while in the abdominal tissue pocket results in joint stiffness at the hand, elbow and shoulder.

The groin flap is a particularly useful flap in burn reconstruction as the groin is usually spared in even large body surface area burns. Use of the groin flap for acute coverage of burned hands has earlier been described in detail [11]. This flap is an axial pattern fasciocutaneous flap based upon the superficial circumflex iliac artery. The artery runs parallel to, and approximately 2–3 cm inferior to the inguinal ligament [12]. This flap can reliably include skin 5 cm inferior and superior to the artery and approximately 5 cm beyond the anterior superior iliac spine. The presence and course of the superficial circumflex iliac artery should be confirmed by Doppler probe prior to elevation of the flap as this vessel is absent in a small percentage of patients. In such cases, a flap may be developed based upon the adjacent superficial epigastric artery. As the flap remains attached to the donor area only by a proximal base, the underside of the flap is easily examined if infection is suspected. Some upper extremity motion is allowed, limiting joint stiffness. Groin flaps tend to be bulky when used to cover hand defects. Secondary liposuction procedures are effective in debulking the flap.

The Tensor Fascia Lata Flap (TFL) is based upon the tensor fascia lata muscle. A fasciocutaneous territory 3–4 times larger than the muscle can reliably be elevated for a total flap size of up to 15 × 14 cm [12,13]. The anterior aspect of the flap is defined as a line running from the anterior superior iliac spine to the lateral tibial condyle [13]. The distal margin is a point approximately 8 cm superior to the knee [12,13]. The posterior border runs along a line drawn from the greater trochanter to the head of the fibula [12,13]. The vascular pedicle, located 6–10 cm below the anterior superior iliac spine, is the axis of rotation, allowing coverage of defects of the groin, sacrum, lower abdomen or hand [13,14]. Use of the TFL flap for hand coverage allows some shoulder and elbow motion prior to division of the pedicle. A disadvantage of this flap in burn patients is the need to place operative incisions on the lateral thigh, normally a prime donor site for split thickness autograft.

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